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10/804,810	03/19/2004	Jonathan J. Wierer JR.	LUM-03-05-01	8900

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PATENT LAW GROUP LLP
2635 NORTH FIRST STREET
SUITE 223
SAN JOSE, CA 95134

EXAMINER	
HO, TU TU V	

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2818	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/804,810	WIERER ET AL.	
	Examiner	Art Unit	
	Tu-Tu Ho	2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 November 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28,32,33 and 38* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-28,32,33 and 38* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *19 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. Applicant's Amendment filed 11/15/2007 has been reviewed and placed of record in the file.

2. Applicant's arguments with respect to amended claims 1-28, 32, 33, and 38, filed 11/15/2007, have been considered but they are moot in view of new ground(s) of rejection.

Claim Rejections - 35 USC § 102

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. Claims 1-2, 4, 8, 13-14, 17-21, and 26-27 are rejected under 35 U.S.C. 102(e) as being anticipated by Erchak et al. U.S. Patent 6,831,302 (the '302 reference, cited in a previous office action).

The '302 reference discloses in Fig. 1 and respective portions of the specification a light emitting device as claimed.

Referring to **claim 1**, the '302 reference discloses a light emitting device comprising:

a (group-) III-nitride semiconductor structure including an active region ("light generation region" 130, column 9, line 10-25) disposed between an n-type and a p-type region (134 and 128); and

a photonic crystal structure (generally indicated at holes 150) formed in at least a portion of the n-type region (134); and

a metal reflector (126, column 9, lines 53-62) disposed on a bottom side of the III-nitride semiconductor structure on at least a portion of a surface of the p-type region (128) opposite the active region (130); and

a contact (136, col. 9, lines 25+) disposed on a top side of the III-nitride semiconductor structure;

wherein a portion of the p-type region proximate the metal reflector is uninterrupted by the photonic crystal structure.

Referring to **claim 2**, the reference further discloses that the photonic crystal structure comprises a periodic variation (column 10, lines 10-15) in a thickness of the n-type region (134).

Referring to **claim 4**, the reference further discloses that the photonic crystal structure (generally indicated at holes 150) comprises a planar lattice of holes (150).

Referring to **claim 8**, the reference further discloses that the planar lattice is triangular (column 10, lines 10-15), satisfying the claimed Markush group of a triangular lattice, a square lattice, a hexagonal lattice, and a honeycomb lattice.

Referring to **claims 13 and 14**, since the reference does not teach intentionally filling the holes (150) with a material or removing air from the holes, the holes (150) are filled with air, a natural dielectric material, which has a dielectric constant of 1, which meets the claimed limitation of a dielectric constant of about 1 and about 16.

Referring to **claims 17-20**, the reference teaches that the total thickness of the group-III nitride semiconductor layers including the n-type region (134, having a thickness of 320 nm, column 9, lines 10-20), the active region (130, having a thickness of 120 nm, column 9, lines 10-20), and the p-type region (128, having a thickness of 40 nm, column 9, lines 10-20) is about 480 nm, which is about the thickness as claimed of less than 0.5 μm (500 nm) or of less than 1 μm (1000 nm).

Referring to **claim 21**, the reference further discloses that a portion of the reflector underlies the photonic crystal structure.

Referring to **claim 26**, the reference further discloses that the reflector (126) comprises silver (column 9, lines 14-17).

Referring to **claim 27**, the reference further discloses that the photonic crystal structure is formed in a first portion of the n-type region (134), the device further comprising a contact (136) formed on a second portion of the n-type region, the second portion being substantially free of the photonic crystal structure.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

4. **Claims 3, 5-7, 9-12, and 15-16** are rejected under 35 U.S.C. §103(a) as being unpatentable over Erchak et al. U.S. Patent 6,831,302 (the '302 reference, cited in a previous office action).

Referring to **claims 3, 6, and 10-12**, although the reference does not teach a range of ratios of the period of the periodic structure and the wavelength of light emitted by the active region as claimed, the reference discloses that the period and the diameter of the holes 150 and the periodic structure of the photonic crystal structure comprising holes 150 can change (column 10, lines 14-16), and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claims 5 and 6**, although the reference does not teach a range of the depths for the holes as claimed, as detailed above, the reference disclose that the depth of the holes can be changed (column 10, lines 10-16), and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claim 7**, although the reference does not disclose a range of greater than a value of the radiation (light) emitting or exiting the device as claimed, the reference teaches improving light extraction efficiency and increasing light output (column 10, lines 25-30), and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claim 9**, as detailed above for claim 8, the reference discloses that the planar lattice is triangular, satisfying the claimed Markush group of a triangular lattice, a square lattice, a hexagonal lattice, and a honeycomb lattice; however, the reference fails to teach that the planar lattice includes more than one lattice type as recited in claim 9. Nevertheless, as the reference does not teach that the planar lattice must be a single planar lattice type, such a change to include more than one lattice type would have been obvious to one of ordinary skill in the art at the time the invention was made.

Referring to **claim 15**, although the reference does not disclose a range of a distance between the reflector and the photonic structure as claimed, the reference teaches that the depth

of the holes can be changed (column 10, lines 14-16), and because the holes, which define the photonic structure, do not reach the reflector layer 126, the reference in effect teaches that a distance between the reflector and the photonic structure can be changed, and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claim 16**, although the reference does not teach a distance between a center of the active region (130) and the photonic crystal region is less than a distance as claimed, the reference teaches that the depth of the holes can be changed (column 10, lines 14-16), and because the holes, which define the photonic structure, do not reach the active region 130, the reference in effect teaches that a distance between the active region and the photonic structure can be changed, and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

5. **Claims 1-28, 32-33, and 38** are rejected under 35 U.S.C. §103(a) as being unpatentable over over Scherer et al. U.S. Patent 6,534,798 (the '798 reference, cited in a previous office action) in view of Lester U.S. Patent 6,091,085 (cited in a previous office action) and further in view of Lee et al. U.S. Patent Application Publication 20050173717 (cited in a copending application).

The '798 reference discloses a light emitting device having metal clad semiconductor microcavities with period texturing on a top, semitransparent metal layer (Figs. 1-3, col. 4, lines 20-67), overlying a III-nitride light emitting layer (which is termed a semiconductor core or membrane 12, Figs. 1 and 3, cols. 1-4, particularly col. 1, lines 30-50, col. 4, lines 20-67), which in turn overlying a reflector 18, which in turn overlying a substrate 20. The reference further teaches various sizes and shapes as recited in **claims 3-6, 8-12, 15-16, and 38** (cols. 3-5), teaches that air could fill the photonic crystal structure (Fig. 7), which air has a dielectric constant of 1 as required in **claims 13-14**, further teaches a thickness for the III-nitride layer (Abstract and cols. 3-4) meeting the various thickness of the III-nitride layer as recited in **claims 17-20**, specifically teaches a metal silver layer (18) as required in **claims 1, 21, and 26** (Figs. 1-3, and as detailed

above), discloses a host substrate (20, Figs. 1, col. 5, lines 1-50) similar in scope as recited in **claims 22-25**, and although not disclosed, intended use of the output light as recited in **claim 7**.

The '798 reference further discloses that comparing with a traditional light emitting device. i.e., a light emitting device without said microcavities and period texturing, light extraction efficiency is increased about 35% (col. 4, lines 30-35).

However, the reference does not disclose: (i) forming a photonic crystal structure in at least a portion of the n-type region and in a portion of the doped III-nitride light emitting layer, wherein a portion of the p-type region proximate the metal reflector is uninterrupted by the missing photonic crystal structure; and (ii) a contact disposed on a top side of the III-nitride semiconductor structure.

Nevertheless, for (i), Lester in the '085 reference, in also disclosing a light emitting device including a III-nitride layer and a photonic structure as detailed above, teaches that a photonic structure ("light pipes"), which is a pattern of holes (Fig. 7), should extend down into at least a portion of the n-type region (or the p-type region) and into a portion of the doped III-nitride light emitting layer so as to increase light intensity (col.5, lines 20-67), up to 70-80% more light than similar light emitting device without light pipes (col. 5, lines 50-60). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '798 reference's device such that a photonic structure is formed at least in a portion of the n-type region (or the p-type region) and in a portion of the doped III-nitride light emitting layer, in place of or in addition to microcavities in the metallic layer. One would have been motivated to make such a change to obtain a light intensity increase of about 70-80% (instead of or in addition to the about 35% increase as in the case of the microcavities in the metal layer). Furthermore, such a modification would result in a photonic structure that does not completely penetrate through the III-nitride semiconductor light emitting layer 12, Fig. 1H (the same way the photonic structure of Lee does not completely penetrate through p-n junction 32, Fig. 7) which includes a p-type region which is in contact with metallic silver reflector 18; hence, meeting the claimed limitation wherein a portion of the p-type region proximate the metal reflector is uninterrupted by the photonic crystal structure.

As for (ii), Lee, in disclosing a light emitting device, teaches a contact ("electrode" 127, Fig. 2, 312, Figs. 3's, Figs. 4's paragraph(s) [0019], [0022],) disposed on a top side of

semiconductor light emitting structure so as to result in a device that works (since it is known that the device requires electrical power via the contact to function). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '798 reference's device to include a contact disposed on a top side of the III-nitride semiconductor structure. One would have been motivated to make such a change to obtain a light emitting device that is workable.

Furthermore, in reference to **claim 27**, Lee further teaches that a contact is formed on a second portion of an n-type region, the second portion being substantially free of a photonic crystal structure (Figs. 3B and 4B).

Furthermore, in reference to **claim 28**, Lee further teaches that a contact surrounds a photonic crystal structure (Fig. 3B, paragraph(s) [0022]).

6. Claims 1-16, 21, 26-28, 32-33, and 38 are rejected under 35 U.S.C. §103(a) as being unpatentable over over Joannopoulos et al. U.S. Patent 5,955,749 (the '749 reference, cited by Applicant) in view of availability of III-nitride semiconducting material, for example disclosed in U.S. Patent Application Publication 20040165850, and further in view of Lee et al. U.S. Patent Application Publication 20050173717 (cited in a copending application).

The '749 reference discloses a light emitting device having a semiconductor structure including an active region (506, Fig. 5, col. 7, lines 55-67) disposed between an n-type and a p-type region (504 and 508); and

a photonic crystal structure (generally indicated at elements 510, col. 8, lines 9-67) formed in at least a portion of the p-type region and at least a portion of the n-type region; and

a metal reflector (silver reflector 622, col. 8, lines 45-55) disposed on at least a portion of a surface of the n-type region opposite the active region (18);

wherein a portion of the n-type region proximate the metal reflector is uninterrupted by the photonic crystal structure.

The reference further teaches various sizes and shapes as recited in **claims 3-6, 8-12, 15-16, and 38** (cols. 3-6), teaches that air could fill the photonic crystal structure (col. 8, lines 10-15), which air has a dielectric constant of 1 as required in **claims 13-14**, does not restrict a particular thickness for the III-nitride layer, specifically teaches a metal silver layer (col. 8, lines

45-55) as required in **claims 1, 21, and 26** (Figs. 5-6, and as detailed above), the photonic crystal structure extending into the active region, the photonic crystal structure extending into the n-type and p-type regions as required in **claims 32-33**, and although not disclosed, intended use of the output light as recited in **claim 7**.

However, the '749 reference: (i) does not teach that the semiconductor structure is a III-nitride semiconductor as claimed; (ii) in the embodiment of Figs 5-6, shows a substrate/metal reflector/n-region/active region/p-region instead of the claimed substrate/metal reflector/p-region/active region/n-region; and (iii) does not disclose a contact disposed on a top side of the III-nitride semiconductor structure.

Nevertheless, for (i), at the time the invention was made, it had been known to artisans in the light emitting art that III-nitride semiconductor was a known and suitable material for light emitting device. See, for example, U.S. Patent Application Publication 20040165850, paragraph(s) [0056]) for the known and variously available materials. One would have been motivated to make a change between the known, available, and suitable materials, for example, from that disclosed by the reference and III-nitride semiconductor, for the purpose of, for example, flexibility in purchasing materials.

As for (ii), it is clear to *one of ordinary skill in the art* that the difference is that of an "intended use", the various relative laying out of the positive (p-type) and negative (n-type) claddings and the eventual corresponding positive (p-type) and negative (n-type) electrodes and/or contacts, and such laying out was within routine skill of the artisan. And furthermore, switching the relative positions of the n-type and the p-type of the reference would also result in the now claimed limitation wherein a portion of the p-type region proximate the metal reflector is uninterrupted by the missing photonic crystal structure.

And for (iii), Lee, in disclosing a light emitting device, teaches a contact ("electrode" 127, Fig. 2, 312, Figs. 3's, Figs. 4's paragraph(s) [0019], [0022]) disposed on a top side of a semiconductor light emitting structure so as to attain a device that works (since it is known that the device requires electrical power, via the contact, to function). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '749 reference's device to include a contact disposed on a top side of the III-nitride semiconductor

structure. One would have been motivated to make such a change to obtain a light emitting device that is workable.

Furthermore, in reference to **claim 27**, Lee further teaches that a contact is formed on a second portion of an n-type region, the second portion being substantially free of a photonic crystal structure (Figs. 3B and 4B).

Furthermore, in reference to **claim 28**, Lee further teaches that a contact surrounds a photonic crystal structure (Fig. 3B, paragraph(s) [0022]).

Response to Arguments

7. In response to applicant's argument that III-nitride material cannot be readily substituted for the GaAs-based material of Scherer's device (the '798 reference's device) ("Applicant Arguments/Remarks Made in an Amendment", filed 11/15/2007, page 7, sheet 3), it is respectfully pointed out that the '798 reference **discloses** the use of the III-nitride material (a III-nitride light emitting layer (which is termed a semiconductor core or membrane 12, Figs. 1 and 3, cols. 1-4, particularly col. 1, lines 30-50, col. 4, lines 20-67)); therefor, no substitution is required. As provided in MPEP, "The use of patents as references is not limited to what the patentees describe as their own inventions or to the problems with which they are concerned. They are part of the literature of the art, relevant for all they contain" and "A reference may be relied upon for all that it would have reasonably suggested to one having ordinary skill the art, including nonpreferred embodiments", MPEP 2123 [R-5].

As for the argument that Scherer (the '798 reference) teaches sway from combination with Lester (the '798 reference teaches **trapping** of pump photons within the microcavity, Lester teaches **extracting**) and the assertion that the examiner has ignored this argument ("Applicant Arguments/Remarks Made in an Amendment", filed 11/15/2007, page 8), it is respectfully pointed out that the '798 reference's **trapping** of pump photons within the microcavity is within the microcavity formed in a contact-type **metallic layer** (cols. 4 and 5, particularly col. 4, lines 20-40 and col. 5, lines 35+ "the pattern is transferred into the top semitransparent metal layer 22 using Ar+ ion milling at a beam voltage of 1500V as shown in FIG. 1g."); whereas, Lester's **extracting** occurs in the light pipes in **said III-nitride semiconductor structure**. Thus, Applicant has not clearly established for the record how the teaching of trapping of pump

photons within a metallic layer of the '798 reference teaches away the extracting in a III-nitride semiconductor structure by Lester. The argument, as of now, is analogous to saying that the trapping or collecting electrons of a positive electrode teaches away the extracting or removing of electrons from a negative electrode.

8. In response to applicant's argument that III-nitride layers cannot be readily transferred from a growth substrate to a metal layer ("Applicant Arguments/Remarks Made in an Amendment", filed 11/15/2007, page 8), it is respectfully pointed out that because Applicant has not provided evidence for the record showing the non-coexistence of a III-nitride layer on a metal layer, such a coexistence or combination is assumed to be operable. See MPEP 2121 [R-6].

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office Action. See MPEP § 706.07(a).

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tu-Tu Ho whose telephone number is (571) 272-1778. The examiner can normally be reached on 6:30 am - 3:00 pm, Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven H. Loke can be reached on (571) 272-1657. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

01-30-2008
/Tu-Tu V. Ho/
Primary Examiner, A.U. 2818